

Claims

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1. Method for pre-emphasis of an optical wavelength division multiplex signal, of which the signals with different wavelengths assembled in groups (B1, B2, B3, B4) are transmitted over express channels as well as over drop channels, add channels or add-drop-channels of a transmission link (LWL) with a number of sections and network elements (WE) such as injection points, drop points (OADM) and termination points,

with the express channels being transmitted from a first network element (NE1) to a second network element (NE2) while drop channels add channels or add-drop channels are also injected at drop points (OADM) arranged between the first and second network element, characterized in that, in a network element for termination of at least one group (B1) of signals at their injection point (NE, OADM) an average and an individual-channel power setting of the signals this group is undertaken, so that prespecified signal-to-noise ratios(OSNR1) are obtained, whereas for the non-terminated groups (B2, B3, B4) of signals the average power is set at a preceding network element (NE, OADM).

2. Method in accordance with claim 1,  
characterized in that

at the injection point the average signal power of a group with drop channels or add-drop-channels dropped or terminated at a subsequent drop point is reduced in favor of the average signal power of an onwards-routed group of express channels.

3. Method in accordance with claim 1 or 2,  
characterized in that  
the redistribution of the average signal powers between the groups (B1, B2, B3, B4) in injecting or switching network

elements (NE) is undertaken with a signal power regulation.

4. Method in accordance with one of the previous claims.

characterized in that

the average signal-to-noise ratios (OSNR1, OSNR2, OSNR3, OSNR4) or differences between the signal-to-noise ratios of the different groups (B2, B3, B4, B4) of signals at their termination points are predetermined by a network management system.

5. Method in accordance with one of the previous claims 1 to 4,

characterized in that

to determine the power modifications to be made, the initial hypothesis is that all channels at the corresponding point can be changed individually and the average power modification of the channel group is then calculated from this specification.

6. Method in accordance with one of the previous claims.

characterized in that

for control of one of the sub-pre-emphasis settings a network element (NEi, OADMj) is activated with the aid of a data packet which is transmitted outwards and backwards from the first injection point (NE0) to the other network element (NEi, OADMj) section-by -section and which contains a marking (X) of the injection and termination points of each of the groups (B1, B2, B3, B4) of signals.

7. Method in accordance with claim 6,

characterized in that

at a network element (NEi, OADMj) the data packet is used for control of one of the additional individual-channel pre-emphases of one of the groups (B1, B2, B3, B4) of signals.

8. Method in accordance with claim 6 or 7,

characterized in that  
for control of the direction of transmission and the range of  
the data packet between the network elements (NEi, OADMj) a  
counter (COUNT) is initialized, incremented or decremented in  
the data packet.

9. Method in accordance with one of the previous claims.

characterized in that  
depending on the type of encoding of the counter (COUNT) and  
of a marking (X) for dropping a group (B1, B2, B3, B4) a  
regulation protocol provided at a selected controlling network  
element for control of pre-emphasis steps with sub-pre-  
emphasis settings and/or the additional individual-channel  
pre-emphasis of the groups (B1, B2, B3, B4) along the  
transmission link (LWL) is selected.

10. Method in accordance with claim 9,

characterized in that  
on receipt of a data packet for which the counter (COUNT) has  
the value "0", a network element (NE1, OADM1, OADM2...)  
assumes control of the pre-emphasis steps for its subsequent  
network sections and that in this case the counter (COUNT) is  
incremented to the value -1.

11. Method in accordance with claim 9 or 10,

characterized in that  
on receipt of a data packet for which the counter (COUNT) has  
the value "1" at a network element (NE1, OADM1, OADM2...), a  
spectrum of the signals as well as the data packet from the  
next network element (OADM1, OADM2, NE2) are sent back along  
the transmission link (LWL) and that on the backwards journey  
of the data packet through each network element (NE2, OADM2,  
OADM1) without termination point, for all groups of channels  
there the counter (COUNT) is increased by the value 1,

otherwise remaining unchanged.

12. Method in accordance with claim 11,  
characterized in that  
for an unchanged counter (COUNT) the data packet is  
transmitted in an opposite direction.

13. Method in accordance with one of the claims 10 to 12,  
characterized in that  
at one of the network elements (OADM1, OADM2, NE2) with a  
termination of at least one of the groups of channels, a  
marking (X) is activated in the transmitted data packet for  
this (these) group(s) and  
the marking (X) for a group is deleted at the injection point  
of the same group on return of the data packet.

14. Method in accordance with one of the claims 10 to 13,  
characterized in that  
on receipt of a data packet of which the counter (COUNT) has a  
higher value than 1 at a network element (NE1, OADM1,  
OADM2...) the counter (COUNT) of the data packet transmitted  
forwards - i.e. in the direction from the first network  
element (NE1) to the second network element (NE2) - is reduced  
by 1 if in this case at least one group of channels is not  
terminated, i.e. is let through or is injected.

15. Method in accordance with one of the claims 10 to 14,  
characterized in that  
on receipt of a data packet of which the counter (COUNT) has a  
higher value than 1 at a network element (NE1, OADM1,  
OADM2...) the counter (COUNT) of the data packet transmitted  
backwards - i.e. in the direction from the second network  
element (NE2) to the first network element (NE1) - is  
increased by 1 and  
on arrival of the data packet transmitted in the backwards

direction the counter (COUNT) remains unchanged at the first controlling network element (NE1).

16. Method in accordance with one of the claims 10 to 15, characterized in that on arrival of the data packet transmitted backwards at the first controlling network element (NE1) with a counter (COUNT), for which the value is equal to the value at the same network element (NE1) with the previous forwards transmission of the data packet, the counter is set to the value 0, that the data packet is transmitted forwards to the next network element (OADM2), the counter (COUNT) is incremented by the value 1 and thus the next network element (NE2) is defined as the new controlling network element for control of further pre-emphasis steps.

17. Method in accordance with one of the claims 10 to 16, characterized in that pre-emphasis steps are undertaken at the controlling network element at a group of channels for which a marking (X) is activated there.

18. Method in accordance with claim 9, characterized in that the pre-emphasis steps are controlled at different selected controlling network elements during the transmission of the data packet within the transmission link (LWL).

19. Method in accordance with claim 18, characterized in that a network element which receives a data packet with a counter (COUNT) with the value "1" in an uplink direction UL, returns values of the power spectrum for an unchanged counter to the beginning of the transmission link (LWL) and marks groups of channels which are terminated at this network element.

20. Method in accordance with claim 18 or 19,  
characterized in that  
a network element which receives a data packet with a value of  
the counter (COUNT) greater than "1" in the uplink direction  
UL,

decreases the counter (COUNT) by the value "1" and passes on  
the data packet to the next network element.

21. Method in accordance with one of the claims 18 to 20,  
characterized in that  
a network element which receives a data packet in the  
backwards direction, increases the counter (COUNT) by the  
value "1" and passes the data packet on to the preceding  
network element.

22. Method in accordance with claim 21,  
characterized in that  
for all marked groups of channels which are inserted at the  
network element, an individual-channel pre-emphasis is  
executed and their corresponding markings are deleted.

23. Method in accordance with one of the claims 18 to 22,  
characterized in that  
for all non-marked groups of channels or groups of channels  
not inserted at the network element an equalization of the  
average power is undertaken if the counter (COUNT) has the  
value 1.

24. Method in accordance with one of the claims 19 to 23,  
characterized in that  
if the value of the counter (COUNT) is not "1", an individual-  
channel pre-emphasis for groups of channels marked and  
inserted at the network is performed.

25. Method in accordance with claim 24,

characterized in that  
the average power per group remains constant.

26. Method in accordance with one of the claims 19 to 25,  
characterized in that  
a network element, at which all groups of channels are  
terminated and which receives a data packet in the uplink  
direction UL with a counter (COUNT) with a value "2",  
transmits a data packet with a counter (COUNT) with  
a value of "0" and deactivates markings at the preceding  
network element.

27. Method in accordance with one of the claims 19 to 26,  
characterized in that  
a network element which is not the first element of a network  
section - at which no group of channels will be looped through  
- and which receives a data packet with a counter (COUNT) with  
the value "0" in a forwards or backwards direction, passes the  
packet on without change to the preceding network element.

28. Method in accordance with one of the claims 19 to 27,  
characterized in that  
the value of the counter (COUNT) increases by "1" step-by-step  
from one pre-emphasis-step to another pre-emphasis-step at the  
network element at the start of the network section until the  
receipt of a data packet with a value "1" of the counter  
(COUNT) signals the completion of the pre-emphasis for this  
network section.

29. Method in accordance with one of the claims 19 to 28,  
characterized in that  
a network element, at which all groups of channels are  
terminated preferably at the end of the network section LWL  
concerned and which receives a data packet with a counter  
(COUNT) with the value "0" in the uplink direction UL,

initiates one or more pre-emphasis-steps for the subsequent network section (LWL').